MOLECULAR BIOMINERALIZATION: FROM GENE TO STRUCTURES AND BIO-PRODUCTS

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During animal evolution, biomolecules (e.g., secondary metabolites) and biomaterials (e.g., biominerals) were selected for higher biological efficiency and superior physical properties. In the last 40 years secondary metabolites had been exploited for biomedical applications, resulting in the development of 9-β-Darabinofuranosyladenosine as a first active pharmaceutical ingredient by us[1]. Only recently the fundament for the biotechnological exploitation of biominerals has been laid by the demonstration that the formation of inorganic deposits within organisms is governed by organic molecules or templates. During INORGANIC MINERALIZATION, the conversion of monomers into solid-state material usually occurs through endothermic reactions. Differently for the initiation and maintenance of BIOMINERAL FORMATION, bioseeds and/or organic surfaces and matrices are required. Two categories can be distinguished: (a) biologically induced mineralization and (b) biologically controlled mineralization. During the seed phase of BIOLOGICALLY INDUCED MINERALIZATION processes, organic polymers allow controlled nucleation and crystal growth. For example, marine snow and coccoliths/coccospheres have mineralization potential. Coccoliths/coccospheres have recently been implied by us in the formation of ferromanganese nodules/crusts in the deep sea[2]. These particles/aggregates act as bioseeds and mediate deposition of inorganic materials from an environment that contains the inorganic precursors at nonsaturated conditions. BIOLOGICALLY CONTROLLED MINERALIZATION describes a process that is guided along bioseeds and organic matrices. These organic molecules function as bioseeds and also as scaffold during the subsequent growth phase; examples are mammalian teeth or bones. A special form of biologically controlled mineralization is the enzymatically controlled biomineralization that has been described for the biosilicification process in siliceous sponges[3]. In these animals the enzyme silicatein is catalytically involved in the formation of biosilica. Since then, learning from sponges and mastering nature’s concept of siliceous skeletal element formation inspired many strategies that aim to biofabricate minerals. The first progress has been made in biomedicine and electronics, providing us with strong indications about the power and potential of this new technology[4].

References

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